M/35/002
NRDC

KENNECOTT UTAH COPPER

Draft

Baseline Groundwater Study Monitoring Plan for the Kennecott South Facilities Groundwater Remedial Design

Prepared By: Kennecott Strategic Resources Group

Date: August 14, 2001

Version A

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Kennecott Utah Copper will conduct a Baseline Water Level and Groundwater Quality Study to characterize the current size and location of the Bingham Reservoir low-pH/heavy-metal and elevated-sulfate groundwater plumes. This study is part of the Remedial Design phase of plume remediation in accordance with the Record of Decision for Kennecott South Zone, OU2, SW Jordan River Valley Groundwater Plumes issued by the U.S. EPA and Utah Department of Environmental Quality in 2000. The baseline representation will serve as a starting point against which remedial effects can be compared.

Water levels will be collected in the spring and fall of 2001 on 320 monitoring and production wells. Water quality samples from 96 wells will be analyzed for a comprehensive suite of inorganic analytes. Data will be collected using operating procedures and methods described in the state-approved Ground Water Characterization and Monitoring Plan. Results will be contoured into potentiometric maps and iso-concentration maps and compiled into a final report describing the plume. These data will be used as input into groundwater flow and transport modeling, which will in turn be used to monitor remedial progress and predict plume behavior.

1.0 INTRODUCTION

As part of the Remedial Design on the CERCLA groundwater plume in the Southwest Jordan Valley, Kennecott Utah Copper Corporation (KUCC) will conduct a Baseline Groundwater Chemistry and Water Level Study. The purpose is to create a current representation of the shape and size of the contaminated groundwater plume and to document the status of water level changes in the valley. Future monitoring data will be compared to the baseline representation to evaluate the effectiveness of remediation and its impact on water levels and groundwater quality in the valley. Two types of data will be collected in the baseline study: water level elevation measurements (more than 600 measurements) and groundwater chemistry from well sampling (43 different analytes on each of 96 well samples). A comprehensive report which may include a potentiometric map, a potentiometric-change map, contaminant distribution maps and hydrogeologic cross sections will be prepared. This plan will develop into the long-term monitoring plan for the remedial action using the baseline data as a guide.

2.0 PURPOSE

Data gathered in the baseline study will be used for several purposes:

1. Create a current, pre-remediation representation of the shape and size of the contaminated groundwater plume and determine the status of water level changes in the valley. This will be the "starting point" against which the impacts of remedial extraction and natural attenuation will be measured.
2. Monitoring results will be used to assure compliance with the stipulations of the Record of Decision for Kennecott South Zone Ground Water Plumes (ROD) (EPA and UDEQ, 2000), that is, that groundwater with greater than 1500 mg/L sulfate and/or metals concentrations exceeding state and federal drinking water standards does not migrate off KUCC property.
3. The data will be added to the historical data set of water level and chemical trends. Some wells in the valley currently show falling water levels, reduced head pressure or contaminant migration. Remediation may exacerbate the head loss. It will be necessary to distinguish trends that were in place before remediation from those caused by remedial extraction so that KUCC can mitigate as necessary.
4. Data gathered will be input into the current groundwater flow and transport models and may be used in calibration of a new "subset model" of the Bingham Reservoir plume area as described in Groundwater Modeling Studies Work Plan (KUCC work in progress A). Baseline data will be used to understand where the current model deviates from field

conditions, thereby allowing an initial sensitivity analysis. Areas that are closely simulated by the model can have less frequent monitoring in the long-term monitoring plan and areas that are poorly predicted should be monitored on a more frequent basis.

3.0 PROCEDURES

3.1 METHODS

KUCC's Groundwater Monitoring and Characterization Plan (GCMP) (KUCC 2000) and associated Standard Operating Procedures (SOPs) (KUCC 1999a) will be followed for all sampling and water level measurements. The GCMP has been approved by the Division of Water Quality and is updated on an annual basis. Procedures for documentation and sample handling, equipment maintenance and decontamination, quality control sampling, field measurements, and groundwater sampling are detailed in the SOPs.

3.2 DATA MANAGEMENT

The GCMP specifies how field and laboratory data are managed from the point of collection, through sampling and laboratory handling, to reporting in quarterly and annual reports to the State of Utah Division of Water Quality. In addition to GCMP data management, the Data and Records Management Plan for the Remedial Design (KUCC work in progress B) provides more detail on how data will be managed on the project level and how they will be managed after all GCMP procedures are complete. For example, in addition to being included in quarterly and annual GCMP reports, the final report for the Baseline Study will tabulate the baseline data and discuss the results in detail.

There may be certain types of data that do not go through the complete GCMP data-management procedure. We anticipate that most of the water-level data (all the measurements not collected immediately before well sampling) will be collected using GCMP water-level measurement protocol, but that these data will be entered into a project database instead of the GCMP database; therefore, they would not be included in GCMP quarterly and annual reports. Data will be reviewed by project personnel in a similar manner to the quality control review conducted under the GCMP program. The two data sets will be combined to generate the necessary tables and figures for the final report for the RD Baseline Study and subsequent annual reports.

3.3 QUALITY CONTROL/QUALITY ASSURANCE

Quality control procedures for the GCMP program will be followed for all RD data collection. These procedures are documented in the Quality Assurance Project Plan for the Groundwater Characterization and Monitoring Plan (QAPP) (KUCC 1999b). In addition to the extensive quality control/quality assurance performed according to laboratory and GCMP protocol, project personnel will review data by comparison to historical trends within 90 days of receipt of the data from the laboratory. If data outside the expected trend are identified, the measurement will be investigated. The expected trend will be defined as within plus or minus two standard deviations calculated on the previous eight sampling results for that analyte, or another appropriate statistical evaluation. Typically, a verification of field data collection and laboratory data reduction would be performed first, followed by re-analysis of the sample, if possible. If these actions do not resolve the issue, the well may be re-sampled. If re-analysis or re-sampling results are similar to the out-of-trend data, the data will stand. If these actions suggest the out-of-trend data may be an outlier, a qualifier will be placed in the database. Quality control problems, necessary corrective actions, and effects on data will be documented in the final Baseline Study report and subsequent annual reports. Database management is outlined in more detail in the Data Records and Management Plan for the Remedial Design (KUCC, work in progress B).

4.0 MONITORING PLAN

4.1 WATER LEVELS

4.1.1 Coordination with existing programs

Several existing water-level collection programs are underway in areas that overlap the South Facilities Groundwater plume area monitored under this Baseline Study. About one third of the water levels are measured during routine well sampling as part of the GCMP, most wells along the rangefront near the Eastside Leach Collection System are measured at least semi-annually as part of the Bingham Canyon Mine and Leach Collection System Permit, and water levels in the sulfate extraction area (near wells B2G1193 and K109) and West Jordan municipal well-field areas are monitored semi-annually to track drawdown and recovery throughout the pumping season. Data collected as part of these programs will be used in this study to understand baseline water-level conditions.

TransJordan Solid Waste Disposal Facility also collects quarterly water levels on five monitoring wells located around their facility, approximately 1-2 miles west of the sulfate extraction area. KUCC has a good working relationship with the management of this facility, and we anticipate that their water-level information will be available; however, the data may not be fully qualified for use in baseline analysis because it will not have gone through the same quality control program as the other data and we cannot control when water-level measurement occurs.

4.1.2 Frequency

For the Baseline Study two complete sets of water levels will be collected on the wells identified in section 4.1.3. One set was collected in April and May 2001 before seasonal pumping began. The other set will be collected in October 2001 toward the end of the irrigation season but while large wells in surrounding communities are still pumping. This will show the impact from seasonal pumping. Water levels will be measured at least monthly around pumping wells when the extent of the cone of depression around those wells is being monitored. All measurements will be made in as short a time span as possible. Under normal conditions, this amount of data should take about four working days to collect. Weather or ground conditions may prolong this interval up to about two weeks. We anticipate that at least semi-annual frequency will be continued during the Remedial Action and in sensitive areas around the Zone A (CERCLA plume) extraction locations the frequency will likely be increased to quarterly.

4.1.3 Monitoring Locations

Table 1 lists the 320 wells proposed for water level monitoring for the Baseline Study. The wells include almost every KUCC monitoring well and some private wells in Zone A. As seen on Plate 1, the spatial distribution of monitoring points is more concentrated in the two main areas of RD extraction (the acidic portion of the plume and the sulfate extraction area of wells B2G1193 and K109), as it will be critical to understand the hydraulics of groundwater flow in these areas. Many of the sites are nested wells which will allow us to monitor vertical hydraulic gradients.

Locations for long-term monitoring will be selected after the baseline data are evaluated. We anticipate that a reduced number of wells will be monitored regularly as part of the long-term monitoring plan during Remedial Action to provide potentiometric map data, and that the remainder of the wells will be measured less often to check vertical gradients.

Table 1. Wells for Baseline Water Level Monitoring.

K26	P241B	ECG294	ECG923	ECG1116C
K70	P241C	ECG296	ECG924	ECG1117A
K72	P242	ECG297	ECG925	ECG1117B
K84	P243	ECG299	ECG926	ECG1117C
K105	P244A	W403	ECG926	ECG1118A
K106	P244B	ABC01	ECG928	ECG1118B
K120	P244C	ABC02	LTG929A	ECG1118C
W131A	P248A	ABC04	LTG929B	BSG1119A
P190A	P248B	ABC04A	ECG931	BSG1119B
P190B	P248C	ABC05	ECG932	BSG1119C
P191A	P249A	ABC06	ECG934	B1G1120A
P191B	P249B	ABC07	ECG935	B1G1120B
P192A	P257	ABC08	ECG936	B1G1120C
P192B	P260	ECG900	ECG937	ECG1121A
P193A	P261	ECG901	ECG938	ECG1121B
P193B	P263	ECG902	ECG939	ECG1121C
P194A	P264	ECG903	ECG940	HMG1122A
P194B	P267B	ECG904	SRG945	HMG1122B
P197B	P268	ECG905	SRG946	HMG1122C
K201	P269	ECG906	B1G951	HMG1123A
P208A	P270	ECG907	ECG952	HMG1123B
P208B	P271	ECG908	BRG999	HMG1123C
P209B	P272	ECG909	ECG1113A	ECG1124A
P211A	P273	LRG910	ECG1113B	ECG1124B
P211B	P274	LRG911	ECG1113C	ECG1124C
P212A	P277	LRG912	ECG1114A	BSG1125A
P212B	P279	LRG914	ECG1114B	BSG1125B
P214A	BRG286	ECG915	ECG1115A	BSG1125C
P220	BRG287	ECG916	ECG1115B	HMG1126A
P225	BRG288	ECG917	ECG1115C	HMG1126B
P228	BRG289	BRG919	ECG1115D	HMG1126C
P231	BRG290	BRG920	ECG1115E	LTG1127A
P239	BRG291A	BRG921	ECG1116A	LTG1127B
P241A	ECG293	ECG922	ECG1116B	LTG1127C

ECG1128A	LTG1140B	B2G1157B	COG1178B	ECG1199B
ECG1128B	ECG1142A	B2G1157C	COG1178C	ECG1199C
ECG1128C	ECG1142B	BCG1158A	BSG1179A	ECG1199D
LTG1129A	ECG1142C	BCG1158B	BSG1179B	ECG1199E
LTG1129B	ECG1143A	BCG1158C	BSG1179C	ECG1199F
LTG1129C	ECG1143B	EPG1165A	BSG1180A	ECG1199G
BSG1130A	ECG1143C	EPG1165B	BSG1180B	EPG1689
BSG1130B	ECG1144A	EPG1165C	BSG1180C	WJG1980
BSG1130C	ECG1144B	EPG1166	ECG1182A	WJG1981
ECG1131A	ECG1144C	LTG1167A	ECG1182B	WJG2453
ECG1131B	ECG1145A	LTG1167B	ECG1183A	LTG1139
ECG1131C	ECG1145B	LTG1167C	ECG1183B	ECG1146
BSG1132A	ECG1145C	BFG1168A	ECG1184	LTG1147
BSG1132B	BSG1148A	BFG1168B	ECG1186	B2G1193
BSG1132C	BSG1148B	BFG1168C	ECG1187	
BSG1133A	BSG1148C	WJG1169A	ECG1188	
BSG1133B	BCG1150A	WJG1169B	ECG1189	
BSG1133C	BCG1150B	WJG1169C	ECG1190	
HMG1134A	BCG1150C	WJG1170A	LTG1191	
HMG1134B	BSG1153A	WJG1170B	B2G1193	
HMG1134C	BSG1153B	WJG1170C	B2G1194A	
BSG1135A	BSG1153C	WJG1171A	B2G1194B	
BSG1135B	WJG1154A	WJG1171B	BFG1195A	
BSG1135C	WJG1154B	WJG1171C	BFG1195B	
BFG1136A	WJG1154C	COG1175A	BSG1196A	
BFG1136B	BFG1155B	COG1175B	BSG1196B	
BFG1136C	BFG1155C	COG1175C	BSG1196C	
BSG1137A	BFG1156A	B2G1176A	B3G1197A	
BSG1137B	BFG1156B	B2G1176B	B3G1197B	
BSG1137C	BFG1156C	B2G1176C	B3G1197C	
LTG1138A	BFG1156D	BSG1177A	BFG1198A	
LTG1138B	BFG1156E	BSG1177B	BFG1198B	
LTG1138C	BFG1156F	BSG1177C	BFG1198C	
LTG1140A	B2G1157A	COG1178A	ECG1199A	

4.2 WATER CHEMISTY

4.2.1 Coordination with existing programs

Some of the wells selected for baseline water chemistry are routinely sampled as part of the GCMP, and many of the wells along the rangefront near the Eastside Leach Collection System are sampled quarterly as part of the Bingham Canyon Mine and Leach Collection System Groundwater Discharge Permit. Data collected as part of these programs will be used in this study to understand baseline water-quality conditions..

TransJordan Solid Waste Disposal Facility also collects quarterly water samples on five monitoring wells located around their facility. Their water-quality information may be available; however, the data may not be fully qualified for use in baseline analysis because it will not have gone through the same quality control program as the other data and we cannot control when sampling occurs or what elements are analyzed.

4.2.2 Analytical suite

Samples will be analyzed for the parameters given in Table 2. The rational for selecting these specific parameters is also listed in the table. The suite includes major and minor analytes as well as trace metals. Major analytes are needed for general chemistry and to calculate charge and mass balance to check the quality of the analyses. Some of the analytes listed in Table 2 were identified as being present in the Bingham Reservoir plume area at concentrations above baseline concentrations in an independent study done as part of the RI (Shepherd Miller, Inc., 1997, page 50). Sulfate, TDS, magnesium, cadmium, nickel and zinc were identified in this study as indicators of elevated concentration of metals related to mining activities. Several elements are not indicators of the plume, according to the report, and were recommended for removal from the list of chemicals of concern. These were barium, mercury, nitrate, and selenium; however, because each of these elements has a primary drinking water standard, and all but mercury are listed in the final clean-up levels in the ROD, KUCC will sample them for this baseline study. It is anticipated that concentrations will be low and these elements may be dropped from the list for the long-term monitoring plan. The study also reported that silver was not an indicator of plume and not found at elevated concentrations, but will be analyzed for the same reasons.

Table 2 also identifies the analytical method and target detection limits for each parameter as given in the QAPP. Analytical methods are selected by laboratory personnel to meet the target detection limits where possible. All analyses will be conducted according to test procedures specified under Utah Administrative Code R317-6-6.3.L for groundwater. Samples will be analyzed by Kennecott Environmental Laboratory, a state-certified lab.

Table 2. Analytical Suite for Baseline Groundwater Samples.

PARAMETER	T/D	RATIONAL FOR SAMPLING	ANALYTICAL METHOD	TARGET DETECT. LIMIT
FIELD				
pH	-	general chem., has drinking water std.	E 150.1	N/A
Temperature	-	general chemistry	E 170.1	N/A
Conductance	-	general chemistry	E 120.1, Std 2510B	10 μmho
Depth to Water	-	indicator of hydraulic changes	N/A	0.01 ft
LAB.				
TDS	-	general chemistry, plume indicator	E 160.1	10 mg/l
TSS	-	general chemistry	E 160.2	3 mg/l
Chloride (Cl^-)	T	general chem., indicator of water source	E 325.2	5 mg/l
Fluoride (F^-)	T	has drinking water std., lack of baseline data, may occur at elevated levels	Std 4500F- E C/300.0	0.2 mg/l
Sulfate (SO_4^{2-})	T	plume indicator	E 375.2, 375.3, 9036	5 mg/l
Nitrate (NO_3^--N)	T	has drinking water standard, to document low levels	E 353.2 0.	2 mg/l
Calcium (Ca)	T	general chemistry	E 200.7	1 mg/l
Magnesium (Mg)	T	plume indicator	E 200.7	1 mg/l
Potassium (K)	T	general chemistry	E 200.7	0.1 mg/l
Sodium (Na)	T	general chemistry	E 200.7	1 mg/l
Alkalinity (ALK)	-	general chemistry	Std 2320B, E 310.1	10 mg/l
Acidity (ACD)	-	general chemistry	Std 2310B	10 mg/L
Aluminum (Al)	TD	above background concentration, needed for mineral acidity calculation	E 200.7, 200.8	200 μg/l
Arsenic (As)	TD	above background concentration	E 200.7, 200.8, 200.9, 6010B, 6020	5 μg/l
Barium (Ba)	TD	to document low levels, has drinking water standard	E 200.7, 200.8, 200.9, 6010B, 6020	10 μg/l
Cadmium (Cd)	TD	plume indicator	E 200.7, 200.8, 200.9, 6010B, 6020	2 μg/l
Chromium (Cr)	TD	above background concentration	E 200.7, 200.8, 6010B, 6020	10 μg/l

PARAMETER	T/D	RATIONAL FOR SAMPLING	ANALYTICAL METHOD	TARGET DETECT. LIMIT
Copper (Cu)	TD	above background concentration	E 200.7, 200.8, 220.1, 6010B, 6020	20 µg/l
Iron (Fe)	TD	plume indicator, needed for mineral acidity calculation	E 200.7, 236.1, 6010B	300 µg/l
Lead (Pb)	TD	above background concentration	E 239.1, 200.8, 200.9, 200.7, 6010B, 6020	5 µg/l
Manganese (Mn)	TD	plume indicator	E 200.7, 243.1, 243.2, 200.8, 6010B, 6020	10 µg/l
Mercury (Hg)	T	to document low levels, has drinking water standard	E 245.1, 200.8	0.2 µg/l
Nickel (Ni)	TD	plume indicator	E 200.7, 200.8, 200.9, 6010B, 6020	30 µg/l
Selenium (Se)	TD	to document low levels, has drinking water standard	E 200.7, 200.8, 200.9, Mod7742, 6010B, 6020	3 µg/l
Silver (Ag)	TD	to document low levels, has drinking water standard	E 272.1, 272.2, 200.8, 200.9, 200.7, 6010B, 6020	1 µg/l
Zinc (Zn)	TD	plume indicator	E 289.1, 289.2, 200.7, 200.8, 200.9, 6010B, 6020	10 µg/l

NOTES: N/A = Not Applicable; E = EPA Method Number; Std = Standard Methods, 20th edition, method number. T/D = Total or Dissolved concentrations.

4.2.3 Sampling frequency

At least one sample from each well identified in section 4.2.4 will be collected in 2001. Many of the wells are sampled more frequently as part of existing monitoring programs. In these cases, the sample results closest in time to the majority of the other Baseline Study samples will be included in the Baseline Study data set. The purpose of this is to have as many samples as possible around the same date to provide a true "snapshot" in time. Samples on this list that were collected prior to July 1, 2001 as part of other monitoring programs may not have been analyzed for the entire suite, but will have results for the major contaminants of concern, so will not be re-sampled.

We anticipate that in the long-term monitoring plan during Remedial Action, wells near pumping centers will be sampled more frequently than areas more distant from pumping.

Existing data show that water quality in several wells in the sulfate extraction area changes markedly in a three month time period, but most wells do not change that frequently, and sampling should be tailored accordingly.

4.2.4 Monitoring Locations

Ninety-six wells have been selected for water quality sampling in the Baseline Study. Wells were selected based on (a) their three-dimensional location in relationship to the acid and sulfate plumes and (b) their historical water-quality trends. The name, location, screen depth and rational for sampling for each site are given in Table 3. Monitoring locations are more dense in the acid plume and the sulfate extraction areas because these are the areas that will be critical to monitor for changes during plume extraction (Plate 2). The margin of the sulfate plume between the sulfate extraction area and West Jordan's municipal well field will also be monitored more densely. Other areas to be monitored include several wells in the Herriman area, around the clean water production well (well ID LTG1139) where supplemental water for plume treatment may be obtained, and a line of wells along the base of the Oquirrh Mountains, where recharge to the alluvial aquifer occurs.

Table 3. Monitoring Locations for Baseline Water Chemistry

Site ID	Sampling rational	KUC northing (ft)	KUC easting (ft)	Screen Top (ft bgs)	Screen Bottom (ft bgs)
W22	Herriman water quality	-1534	23091	80	350
K26	source area (large reservoir)	16448	25287	204	224
K72	alluvium near recharge area	13841	18189	10	240
W107	property boundary	20440	43285	215	460
K109	SO4 extraction	17611	34847	403	520
W189	property boundary	18943	39481	350	637
P190A	1500 mg/L SO4 contour, property boundary	12580	37968	286	296
P190B	1500 mg/L SO4 contour, property boundary	12570	37976	529	539
P208B	acid plume margin	12512	25036	401	412
P241B	acid plume margin	12351	29699	530	570
P241C	1500 mg/L SO4 contour, property boundary	9804	32427	385	405
P244A	alluvium near recharge area	2285	16110	37	47
P244B	bedrock recharge	2278	16123	63	73
P244C	bedrock recharge	2266	16139	107	127
P248A	alluvium near recharge area	15485	17875	80	100
P248B	bedrock recharge	15491	17849	120	140
P248C	bedrock recharge	15496	17828	175	195
P279	acid plume core	14156	24053	395	415

Site ID	Sampling rational	KUC northing (ft)	KUC easting (ft)	Screen Top (ft bgs)	Screen Bottom (ft bgs)
W361	West Jordan well field	25805	37702	225	620
W363	West Jordan well field	23509	37928	380	590
W387	West Jordan well field	23373	35197	379	690
W409	Herriman water quality	-4079	27132	140	505
W412	Herriman water quality	-5469	23323	105	256
LRG910	source area (large reservoir)	16038	18754	77	136
LRG911	source area (large reservoir)	15231	18914	77	136
LRG912	source area (large reservoir)	16539	19577	77	136
ECG917	alluvium near recharge area	6289	18385	150	190
ECG922	alluvium near recharge area	7677	18058	142	181
SRG946	source area (small reservoir)	16988	21598	120	179
B1G951	source area (large reservoir)	16322	21727	92	131
ECG1113A	clean water source area	8508	21783	138	178
ECG1115A	acid plume core	14603	24663	538	578
ECG1115B	acid plume core, base	14603	24663	838	858
ECG1115C	acid plume core, base	14601	24700	898	938
ECG1117A	acid plume core	15047	25243	438	478
ECG1117B	acid plume core, base	15047	25243	758	798
ECG1118A	acid plume core	13882	27446	598	638
ECG1118B	acid plume core, base	13882	27446	818	858
BSG1119B	acid plume, leading edge	13853	32358	538	558
B1G1120A	acid plume core	16141	26693	493	532
ECG1121A	acid plume core	14957	26824	600	640
BSG1125A	1500 mg/L SO4 contour, property boundary	8494	32397	280	320
HMG1126A	Herriman water quality	2682	31045	280	320
HMG1126B	Herriman water quality	2682	31045	380	420
ECG1128A	acid plume margin	12249	25795	418	458
BSG1130A	1500 mg/L SO4 contour	10114	34557	340	380
BSG1133A	1500 mg/L SO4 contour	12400	34000	390	410
BSG1133B	1500 mg/L SO4 contour	12400	34000	600	620
HMG1134A	Herriman water quality	5503	41670	160	180
BSG1137A	1500 mg/L SO4 contour	15300	38000	377	397
BSG1137B	1500 mg/L SO4 contour	15300	38000	637	657
LTG1139	clean water source area	6989	24166	330	980
LTG1140A	clean water source area	6984	23149	220	240
LTG1140B	clean water source area	6984	23149	330	350
ECG1144A	acid plume core	13855	26003	440	460
ECG1145A	acid plume core	13049	25373	420	440
ECG1145B	acid plume core	13049	25373	760	780

Site ID	Sampling rational	KUC northing (ft)	KUC easting (ft)	Screen Top (ft bgs)	Screen Bottom (ft bgs)
ECG1145C	acid plume core, base	13049	25373	810	830
ECG1146	acid plume core	13467	25673	500	750
LTG1147	1500 mg/L SO4 contour	7067	29725	400	590
BSG1148A	acid plume margin	11276	28859	510	530
BSG1148B	acid plume margin	11276	28859	580	600
WJG1154A	SO4 extraction, West Jordan well field	20510	36367	310	350
WJG1154B	SO4 extraction, West Jordan well field	20510	36367	400	420
WJG1154C	SO4 extraction, West Jordan well field	20510	36367	730	750
LTG1167B	Herriman water quality	553	28415	300	320
WJG1169A	1500 mg/L SO4 contour, West Jordan well field	19501	30501	400	420
WJG1169B	1500 mg/L SO4 contour, West Jordan well field	19501	30501	470	490
WJG1170A	SO4 extraction, West Jordan well field	19110	35012	375	395
WJG1171A	SO4 extraction, West Jordan well field	20426	37696	430	450
B2G1176A	acid plume margin	16148	30121	555	575
BSG1177A	acid plume margin	13826	30357	525	545
BSG1177B	acid plume margin	13826	30357	680	700
BSG1179A	acid plume margin	12358	29633	440	460
BSG1179B	acid plume margin	12358	29633	685	705
BSG1179C	acid plume margin	12358	29633	805	825
BSG1180B	acid plume, leading edge	13817	31356	660	680
BSG1180C	acid plume, leading edge	13817	31356	798	818
ECG1183A	alluvial bedrock contact	579	18992	35	65
ECG1184	Butterfield Canyon alluvial recharge to Herriman	-1538	17816	60	80
ECG1186	alluvium near recharge area	9647	18578	36	136
ECG1187	alluvium near recharge area	7540	18458	54	164
ECG1188	alluvium near recharge area	10109	18567	38	118
ECG1189	alluvium near recharge area	13054	19990	205	265
ECG1190	alluvium near recharge area	11715	19026	118	198
LTG1191	alluvium near recharge area	3749	20549	20	100
B2G1193	SO4 extraction	15378	33485	451	881
BFG1195A	SO4 extraction	16434	33104	558	578
BFG1195B	SO4 extraction	16434	33104	679	699
BSG1196B	acid plume, leading edge	13825	31860	470	490
BSG1196C	acid plume, leading edge	13825	31860	650	670
B3G1197A	SO4 extraction, West Jordan well field	17661	38129	340	360
B3G1197B	SO4 extraction, West Jordan well field	17661	38129	460	480
BFG1198A	1500 mg/L SO4 contour, property boundary	17580	30793	400	420
HMG1623	Riverton water quality	5711	48152	134	135
HMG1856	Herriman water quality	657	33611	200	280

5.0 ANALYSIS AND RESULTS

Baseline data will be compiled into data sets and analyzed by project personnel. Analysis may include the application of statistical methods and computer software contouring programs. The results of the Baseline Study will be presented in a final report by January 1, 2002. Tables of all data collected for the Baseline Study will be included in the final report. Figures will include iso-concentration contour maps of sulfate, pH, and selected trace metals and at least one potentiometric map. Also included will be an analysis of vertical hydraulic gradients and the status of water level changes in the Southwestern Jordan Valley. Hydrogeologic cross-sections depicting water quality may be used to show the vertical distribution of groundwater contamination.

Maps and figures will be produced in such a manner as to be easily updated when long-term monitoring reveals changes. Data sets will be created in a format that can be utilized by groundwater flow and transport modeling.

The final report will include recommendations for the long-term monitoring plan. The baseline study data will be combined with the historical data set and possibly with groundwater modeling results to suggest a frequency and analytical suite for long-term monitoring.

6.0 REFERENCES

Environmental Protection Agency and Utah Department of Environmental Quality. 2000. Record of Decision. Kennecott South Zone. Operable Unit 2. Southwest Jordan River Valley Ground Water Plumes. December 13. 130 p.

Kennecott Utah Copper Corporation. 1999a. Standard Operating Procedures for Water Sampling. Version 4. December. 309 p.

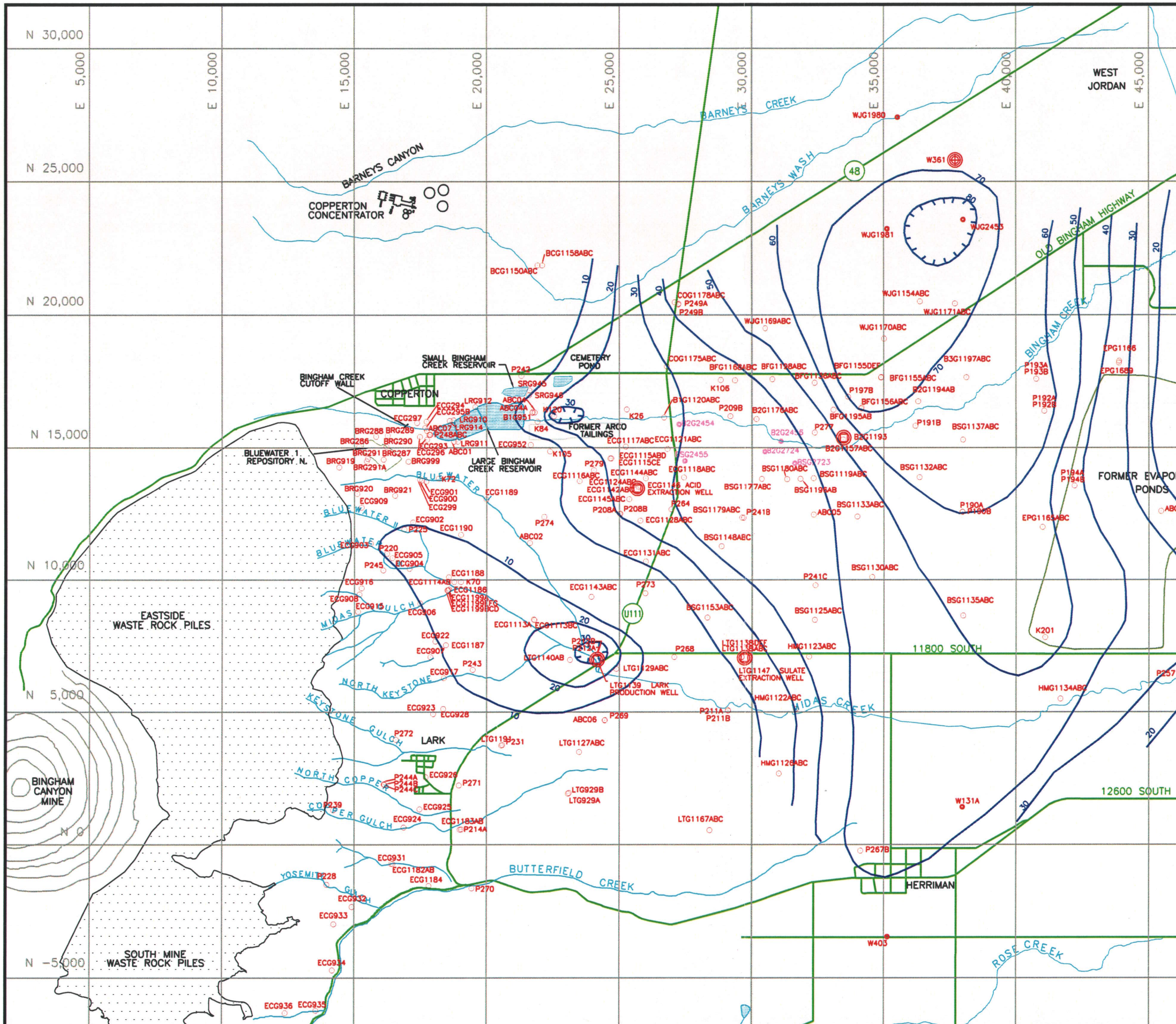
Kennecott Utah Copper Corporation. 1999b. Quality Assurance Project Plan for the Ground Water Characterization and Monitoring Plan. Revision 5. December. 29 p.

Kennecott Utah Copper Corporation. 2000. Ground Water Characterization and Monitoring Plan. revision 6, April, 91 p.

Kennecott Utah Copper Corporation. work in progress A. Groundwater Modeling Studies Work Plan.

Kennecott Utah Copper Corporation, work in progress B, Data Records and Management Plan for South Facilities Groundwater Remedial Design.

Shepherd Miller, Inc., 1997, Determination of Constituents Above Background and Baseline Concentrations in Ground Water, Southwestern Jordan Valley, Utah. June, 51 p. plus appendices. (Included as Appendix B to the Remedial Investigation and Feasibility Study Report, KUCC, 1998)



WELL S

K26 KUC MONI

W403 PRIVATE W

KUC PROD

W361 MUNICIPAL

LEG

K25 WATER LEV

B2G2456 THIRD PART WILL USE

1986 TO 1 DECLINE (I

GRAPHIC SCALE

3000 0 1500 3000

(IN FEET)
1 inch = 3000 ft.

COORDINATES SHOWN ARE IN KENNECOTT TRUE NORTH GRID

N

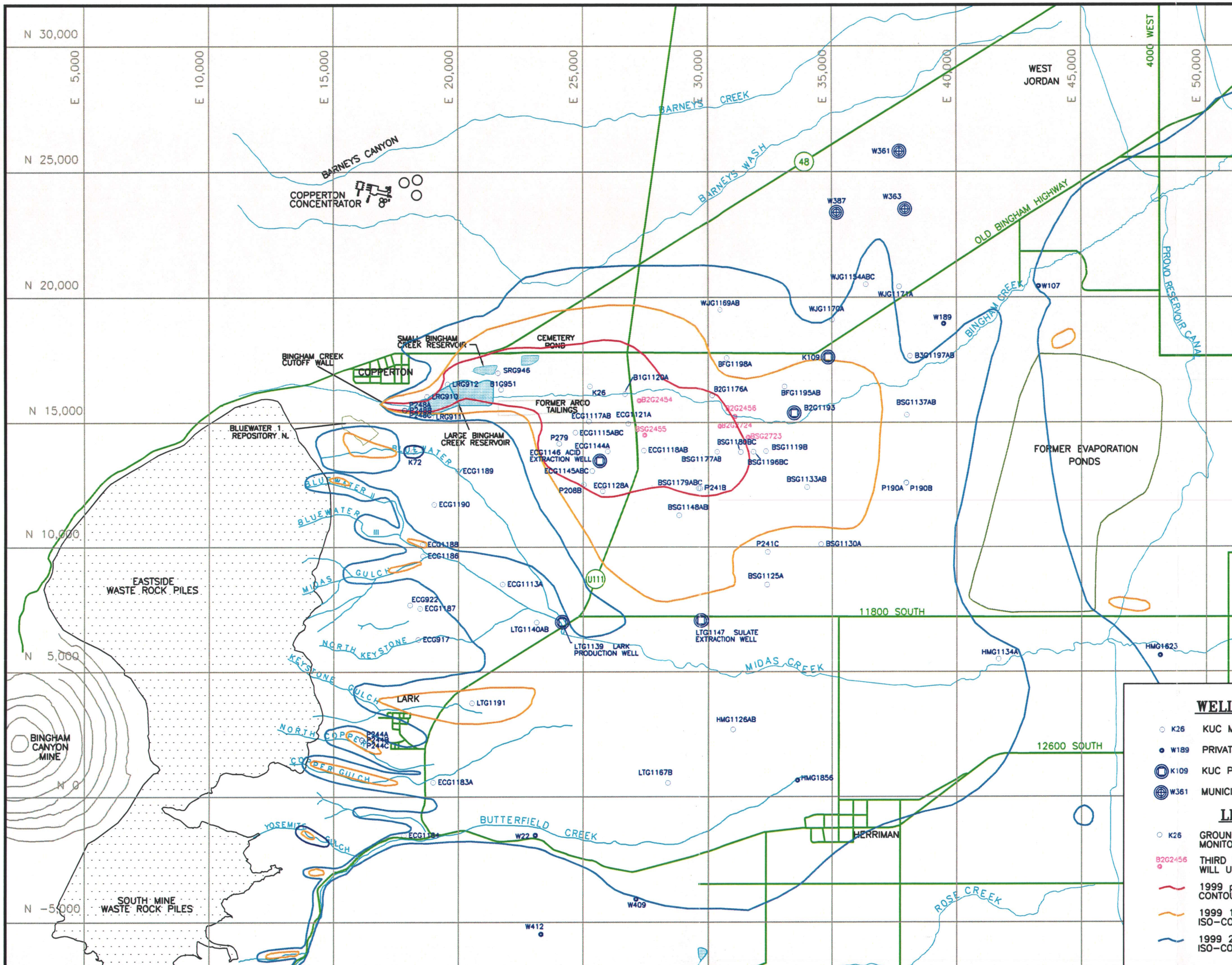
STRATEGIC RESOURCES GROUP

SCALE: 1" = 4500'	DATE
DESIGNED BY JKL	6/25/01
DRAWN BY MWC	6/26/01
CHECKED BY JKL	8/14/01
PROJECT ENGINEER	
PROJECT MANAGER JCC	

KENNEC
UTAH CO
PLATE
RD BASELINE
WATER LEVEL M

Job No. ---

Dwg. No. 4



STRATEGIC RESOURCES GROUP

SCALE: 1" = 4500'	DATE
DESIGNED BY JKL	6/25/01
DRAWN BY MWC	6/26/01
CHECKED BY JKL	8/14/01
PROJECT ENGINEER	
PROJECT MANAGER JCC	

KENNE
UTAH CO
PLATE
RD BASELINE
WATER CHEMISTRY

Job No. ---
Dwg. No. 4